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## Biodiversity and Socio-Environmental Problems of the South-Eastern Baltic Coastal Zone

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With one Table

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### Abstract

The diversity of life occurs at several hierarchical levels of biological organisation, including the biotope (habitats) diversity. The knowledge of the coastal habitat diversity and its sensitivity to the anthropogenic impact is one of the most important preconditions for the sustainable use and development of the coastal regions. This paper gives a brief overview of a recent study, which was aimed to classify the Lithuanian coastal zone underwater habitats and identify anthropogenic threats to the area.

### Introduction

The diversity of life occurs at several hierarchical levels of biological organisation (NORSE 1993). Besides the genetic, species and ecosystem levels (NORSE 1993) also phyletic, functional and habitat diversity is distinguished (GRAY 1997). The later, in opposite to the species diversity, is largely unknown in the Baltic Sea region. This makes a challenge to the Baltic marine and coastal science since the habitat diversity tends to be particularly large in the coastal zone, where, in turn, pollution and overexploitation have been most destructive (HEDLUND et al. 1995). Thus, our knowledge of the coastal habitat diversity and its sensitivity to the anthropogenic impact is one of the most important preconditions for the sustainable use and development of the coastal regions.

In this paper the attempt is made to classify underwater habitats of the Lithuanian coastal zone, and identify anthropogenic threats to the biological diversity at different hierarchical levels.

### Material, Methods and Terminology

The study area is situated at the Lithuanian coast of the Baltic Sea, north of Klaipėda city. It was investigated by remote underwater video during the field seasons 1993–1995 from the shore to the

depth of 20 m, SCUBA divers examined benthic biotopes and collected samples of bottom fauna and flora from the shore down to 15 m. Major visible geomorphological and biological/biogenic features, like sediment type and its heterogeneity, presence of bottom vegetation, blue mussel and barnacle colonies, tubes and holes in the soft sediment, etc., were evaluated according to a uniform semi-quantitative scale: 1 point – a feature is of minor importance, it covers less than 10% of a visible area; 2 points – coverage 10–40%; 3 – 40–60%; 4 – 60–90%; 5 – more than 90%; 0 – absence of a feature. In addition grabs and benthic trawls were used at the depth from 3 to 30 m, the samples of macrofauna were treated according to (HELCOM 1988). Other sources of information (scientific literature, unpublished environmental reports, nautical charts, geomorphological maps, etc.) were analysed. The materials of field observations and laboratory works together with results of the literature analysis were formalised and computer data bases were developed.

In this study the terms “underwater habitat” and “marine biotope” are used as synonyms. They indicate a given area of the sea bottom with more or less uniform geomorphological, lithodynamic and hydrological environment. There is a strong relationship between the physical nature of a habitat and composition of its biological community, especially in such extreme environments like exposed sandy coasts of the Eastern Baltic. Even slight, nearly unnoticeable differences in “physics” are often reflected in quite visible deviations in biological features, therefore they were used in the biotopes classification together with physical characteristics. In general, this approach has a long history (cf. GURJANOVA et al. 1924). At the modern theoretical level it was recently used in several European coastal zone projects (LAFFOLEY & HISCOCK 1993; BELLAN-SANTINI et al. 1994; CONNOR 1995).

### Results and Discussion

#### Regional context

An exposed coast with dunes, wide sandy beaches and gently inclining underwater slope is characteristic for a large Baltic

region from the Pomeranian Bay in the south-west to the Gulf of Riga in the north-east. The Lithuanian coast represents a typical part of this region.

The main peculiarity of our coastal zone is the runoff a highly eutrophied and mostly freshwater body, the Curonian Lagoon. Its water interacts with the south-eastern Baltic water mass with mean salinity of 7–8‰. Due to intensive mixing a vertical salinity gradient is weak (if any) in the coastal zone (OLENIN 1994). The average temperature of the inshore waters varies from –0.3 to 24 °C during a year (AŠMONTAS 1994), showing a typical boreal seasonal pattern. In July–August the summer thermocline is formed at the depth of 20–30 m (KORSHENKO 1991), so nearly the entire coastal zone is influenced by the warm water, which is situated above the thermocline. In winter a fast ice along the shoreline is normal phenomena; its width varies from 20–30 m to several hundred meters and its thickness from 10–15 to 40–50 cm. The ice cover makes no visible damage to the marine bottom fauna and perennial red and brown macroalgae, since their colonies do not occur in the uppermost sandy part of the underwater slope (see below). Being under permanent influence of winds, waves and water currents the area is characterised by very active hydrodynamic, therefore there is no oxygen deficiency and the oxygen based gradients in distribution of biota. The zone of active waves effect extends down to 25–30 m (GUDELIS 1993).

## A marine boundary of the coastal zone

The Lithuanian coastal zone is a complex landform, which includes both terrestrial and marine (inshore waters and an underwater slope) parts. The marine (offshore) boundary of the coastal zone was determined at the depth of 20–30 m by several hydrological, geomorphological and biological criteria: 1) summer thermocline position, 2) lower boundary of the Curonian Lagoon waters penetration into the Sea (PUSTELNIKOV 1990; JOKŠAS 1995), 3) active waves effect, 4) lower limit of distribution of the coarse sandy-gravel sediments (PUSTELNIKOV 1990), 5) approximate boundary of the euphotic zone and lower boundary of benthic vegetation (OLENIN et al. 1996), 6) steep decrease (or complete disappearance) of communities of the bivalve mollusc-filtrators (OLENIN 1997).

## Factors shaping diversity of benthic biotopes in the coastal zone

There are two physical factors, which show distinct gradients in the coastal zone: the bottom substrate (1 – boulders; 2 – pebbles/gravel; 3 – sands; 4 – mud) and wave exposure (1 – swash; 2 – surf; 3 – breakers; 4 – offshore zones); for details see KARTER (1991) and GUDELIS (1993). Theoretically these factors may be combined in a 4 × 4 matrix, showing sixteen possible combinations, like: boulders in the swash

zone, boulders in the breakers zone, sand in the surf zone, sand in the offshore zone, etc. This matrix forms a “template” for biotic communities, and each of them fits into a certain combination (a matrix cell). Some of combinations, however, do not occur in nature: there is no muddy sediment in the active (swash, surf and breakers) hydrodynamic zones. From another side, some of the biological features can suit to more than one of the matrix cells, for instance: colonies of the barnacle *Balanus improvisus* are characteristic for both boulders and pebbles/gravel in the breakers zone.

## Diversity and conservation value of benthic biotopes

Ten biotopes were identified in the coastal zone, which show a distinguishable vertical zonation pattern (OLENIN 1994; OLENIN et al. 1996). Of them the stony bottom biotope with the red algae *Furcellaria lumbricalis* in the offshore zone has shown the highest biodiversity at species level. It occurred at the depth from 4–5 to 12–14 m. The boulders were covered by dense (up to 800 g · m<sup>-2</sup>) canopies of *F. lumbricalis*. They are reported as the best spawning substrate for the Baltic herring *Clupea harengus membras* (GRAUMAN & LISHEVA 1990). Also a wide variety of faunal species occurred in this biotope, including the blue mussel *Mytilus edulis*, the barnacle *B. improvisus*, the spongian *Electra crustulenta*, sedentary polychaetes, various crustaceans, etc.: about 50 species in total (up to 25 species per sample). Formally, this biotope should have the highest conservation value in comparison to the nine others. However, the whole coastal zone represents an indivisible functional integrity, and the mosaic of habitats (habitats diversity) is the main precondition for maintaining of its rich and diverse living resources.

**Table 1.** Classification of human-induced threats to the south-eastern Baltic marine benthic biotopes and communities.

Scale	Threat	Evaluation
Global	Increased frequency of storm events	++
	Sea level rise	?
	Global warming	?
Regional	Eutrophication	++
	Chemical pollution	+
	Invasion of exotic species	? (+)
Local	Discharge of waste waters	++
	Hydrotechnical constructions	(++)
	Oil spills	+(++)
	Disposal of dredged material	++
	Overfishing	? (++)
	Tourists impact on coastal habitats	? (+)
	Amber mining by digging on the beaches	+

+ Present, of low significance; ++ present, of high significance; ? unclear, ( ) potential.

## Present and potential threats to the area

An antropogenic impact assessment on the Baltic Sea coastal waters was made in a recent comprehensive overview (HELCOM 1993). In this paper the attempt is made to classify the threats into global, regional (basin-wide) and local categories (Table 1) without going into details about their nature/origin (physical, chemical, biological, etc.).

This classification is neither complete, nor exhaustive. However it gives an idea about a level, at which the measures are to be undertaken in order to eliminate (or minimise) a threat. It is especially important since the different threats (or impacts) have a synergetic effect. For instance, the increased frequency of storm events during two recent decades (KIRLYS 1990) together with the decreased – due to eutrophication – euphotic zone (HELCOM 1993) have resulted in a 5-fold decline in the *Furcellaria* stock (OLENIN 1994).

## Conclusion

The habitat diversity is one of the important biodiversity aspects. Due to many reasons (political, economical, purely technical, etc.) the south-eastern Baltic coastal waters have been beyond intensive marine research for many years. Now there is need to develop the classification of the Baltic open coasts and marine benthic biotopes in order to get the full range of the Baltic Sea habitat diversity. This is the necessary precondition as for sustainable development of the coastal zone as for the further deeper research on its functioning.

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